

Pressures from Above ...New Methods for Project Delivery

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ABSTRACT

Ever-growing patient demand and rapid changes in technology are increasing pressure to bring high tech projects on line faster. As a result, facility managers and architects for The University of Texas M. D. Anderson Cancer Center (M. D. ANDERSON) have married new methods for delivery with strategies for managing decisions, planning for flexibility and involving stakeholders throughout the process.

BACKGROUND

Celebrating more than six decades of Making Cancer History, The University of Texas M. D. Anderson Cancer Center (M. D. Anderson) is located in Houston on the sprawling campus of the Texas Medical Center. It is one of the world's most respected centers devoted exclusively to cancer patient care, research, education and prevention. M. D. Anderson was created by the Texas Legislature in 1941 as a component of The University of Texas System, with a faculty numbering 1,170 – both M.D.s and Ph.D.s. and a total employee count exceeding 14,000. M. D. Anderson is one of the nation's original three Comprehensive Cancer Centers designated by the National Cancer Act of 1971 and is one of 52 Comprehensive Cancer Centers in the U.S. today. M. D. Anderson ranked among the nation's top two cancer hospitals in U.S. News & World Report's "America's Best Hospitals" survey since its inception 15 years ago, has been ranked number one, four times in the last five years.

GROWTH

Over the last several years M. D. Anderson has experienced unprecedented demand for its services. The campus size has been challenged to keep pace with the growth despite the addition of almost a million square feet in 1997. Increases by area, showing average annual growth from Fiscal Year 1997 – Fiscal Year 2000

- Outpatient visits increased 19% (total outpatient revenue as a percentage of total revenue is now 50% compared to 44% in FY'95)
- Surgeries rose an average of 9% per year
- Patient days increased an average of 4% per year
- Diagnostic imaging procedures averaged a 12% annual increase
- Pathology/laboratory procedures increased an average of 13% per year
- Pharmacy averaged an increase of 20% per year

Estimates completed in 2000 indicated that demand for services would continue to drive growth by an estimated 10% per year. These demand models conservatively estimated growth of outpatient visits at 5% per year, surgeries at 5% per year and patient days at 4% per year. During this time, diagnostic imaging procedures were projected to increase 5% per year and pathology/laboratory procedures would increase 9% per year. As a result of these volume increases, pharmacy will increase an average of 18% per year.

The need for growth for Radiation Oncology services is directly proportional to the number of new patients seen at M. D. Anderson. Capacity at the main campus was capped at 4,000 new Radiation Oncology patients per year, based on 10-hour days and an 85% efficiency utilization of 14 existing linear accelerator treatment vaults. Growth projections for FY '04 indicated 6,600 new patients per year with estimates of more than 9,000 new patients in FY '09. Included in these projections was expansion to re-capture lost business that could not be met due to limited facilities.

FACILITIES RESPONSE TO GROWTH – THEN AND NOW

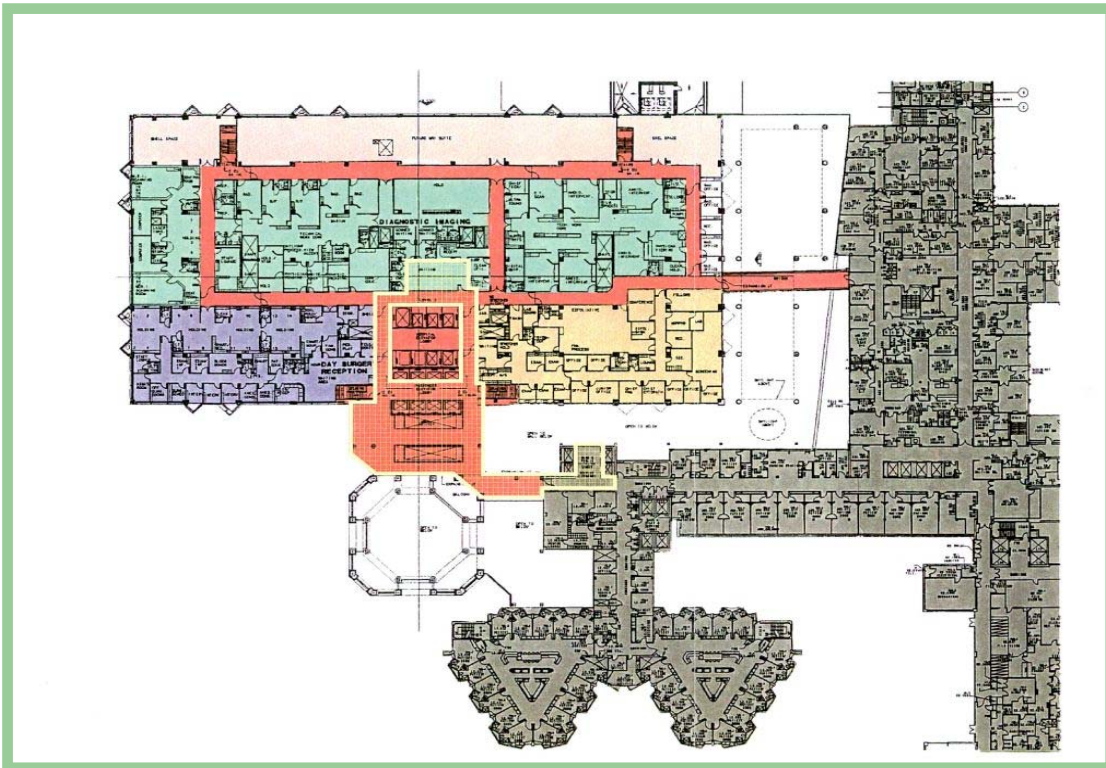
Originally it was thought that these growth projections could be met through construction of a Faculty Center adjacent to the main campus to allow additional space on campus for clinical purposes. However, projections done in 2000 left a deficit of over 120,000 square feet of exam and procedure space, with even larger unmet needs in diagnostic medicine and treatment space. After exhaustive analysis of all options, M. D. Anderson concluded that the only practical alternative was to accelerate the implementation of its long-term master plan. This plan eventually called for development of the 26-acre Houston Main Building (HMB) site for clinical purposes. Site studies indicated that the phased development of 2.0 million square feet is possible

Based on the growth and projections in 2000, executives at M. D. Anderson realized they needed to implement a faster design and construction process than the traditional design, bid, build process that had been utilized on the Bertner Expansion completed in 1998. While this strategy had worked well, it took almost a decade to bring the project on line. The design/build delivery method was utilized for the Faculty Center, which resulted in faster delivery and successful cost control. As M. D. Anderson considered its next expansion and the need for expediency they determined that the design/build delivery method and a fast tracked project would be appropriate for the next major expansion, the Ambulatory Clinical Building (ACB).

Project Director, Janet Sisolak who led the Bertner Expansion during its activation was chosen to lead the Ambulatory Clinical Building project. Knowing what worked well with the Bertner project and how technology decisions impacted the design and construction, strategies for the new ACB were now applied to a much faster delivery process. The following will highlight how two similar projects with different delivery processes embraced technology and accommodated changes.

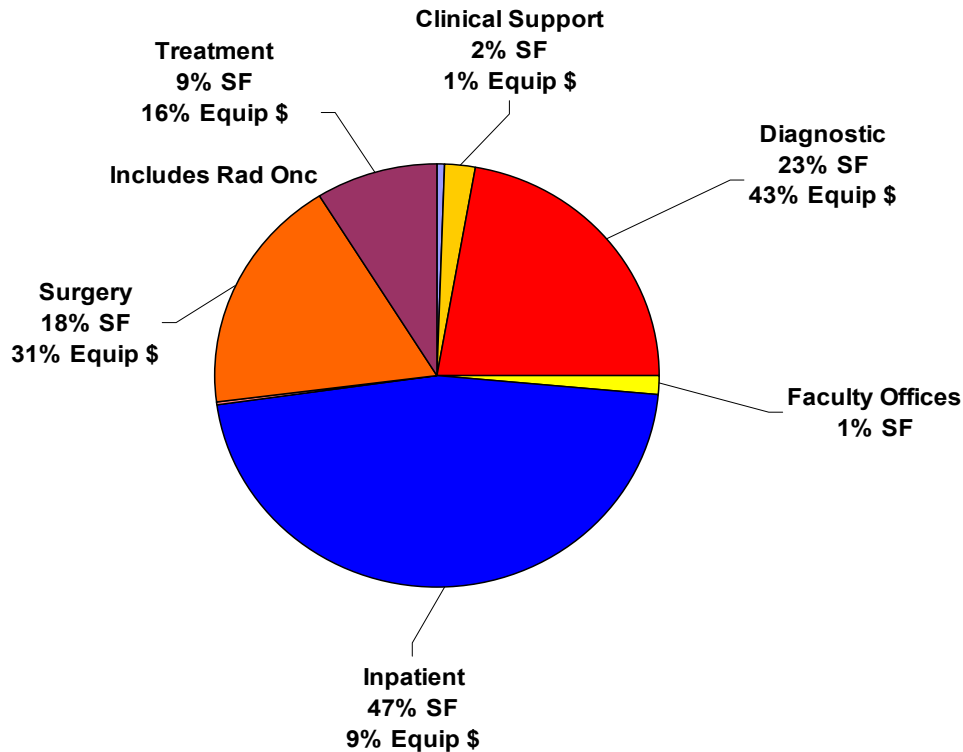
The Albert B. and Margaret M. Alkek Hospital

Completed in 1998, the Albert B. and Margaret M. Alkek Hospital was part of the 1,000,000 square foot Bertner Expansion project. Alkek was the largest of three projects designed and built as additions to the main campus. The thirteen story Alkek Tower consists of 375,000 BGSF with 140 inpatient beds and a base block including 48 ICU beds, a surgical suite with 30 operating rooms, a 12-room Diagnostic Imaging suite, Radiation Oncology services with 8 vaults, Physical therapy and Pathology services. Diagnostic Imaging services inner-connect with the existing facility, making the horizontal stretch of Imaging services span over a quarter of a mile, from outpatient MRI services in the east to Interventional Radiology services on the west.



The Bertner Expansion started with master planning in late 1989. Planned as a typical design-bid-build project, construction for the core and shell was accelerated prior to completion of design to respond to political pressures at the time and construction began in 1993. Final buildout took almost 4 years making the overall duration of the entire project 9 ½ years in length. The Alkek facility opened in November of 1998. The gap in timing from the master planning, programming and design development and the occupancy dates resulted in MCACC paying more than \$6 million in changes related to program and technology.

The initial construction estimate was \$126,000,000* for the shell, core and buildout of Alkek and included \$6,000,000* in contingencies. The project actually experienced \$15,400,000 in changes, which resulted in a final construction cost of \$141,500,000*. Technology accounted for 10% of the total increase. While 47% of the total space was devoted to repetitive inpatient beds, 49% of the space comprised complex technology areas including Imaging, Surgery and Radiation Oncology. Unlike the equal division of square footage between lower tech and hi tech, the equipment budget included 10% for inpatient and soft space with 90% of the equipment budget allocated to Imaging, Surgery and Radiation Oncology. Total equipment budget on the Alkek tower was \$32,300,000.



* Dollars inflated to 2004 for comparison

Several strategies were used in the Alkek to try to manage the anticipated impact of technology. The construction of the core and shell began with no interior layouts. The entire third floor where Imaging was to reside, was provided with a continuous slab depression in anticipation that at the time of pouring the concrete, decisions would be have been made regarding the location electrical rough-ins and base plates. To address ceiling mounted equipment, universal unistrut ceiling grids were used in Imaging rooms to provide flexibility and allow structural connection to mount any variation of a vendors system. An interstitial floor design was used between high technology floors, specifically between key areas like Imaging and Surgery and Surgery and ICU, to allow future technology changes in plumbing, mechanical or electrical needs to occur without disruption to occupants and current operations.

While technology decisions were requested during early planning, Alkek was impacted by changes in Chairmanships as well as technology changes. As a result by the time the contractor was ready to place studs on the Imaging floor, the radiologists were not ready to cast their equipment decisions in stone (or concrete!).

Needing to proceed with construction, the slab depressions were infilled with lightweight concrete, which had to be saw-cut at a later date when final location for floor penetrations, conduits and floor ducts was known. The project experienced delay due to the customization of each room to the model selected.

Radiation Oncology planned for eight vaults and based the design on the manufacturer of choice. In this case a purchase order was actually signed during schematic design and the room was designed around the manufacturer. No changes occurred either to the manufacturer or to the model.

Lessons Learned on Alkek – Evaluating Technology Strategies

The use of interstitial floors was a costly investment but one that has proven useful in the six years the building has been in use. However no study had been conducted to review at renovations in the OR's or Imaging to measure the benefits of the interstitial floor. . Areas planned for shell space in Surgery are being built as planned and the interstitial floor will afford convenient access above and below without disruption. Quantifying that benefit versus having additional space to generate revenue has not been attempted.

The universal ceiling grids were very helpful in allowing for completion of MEP systems without having final equipment installation information. However, no cost analysis has been conducted to support their future use. This approach may have limited application to general radiography and radiography/fluoroscopy rooms with many vendors providing floor mounted systems.

Finally, while addressed flexibility for ceilings and floor infrastructure, they did not address room sizing. Many areas had to be completely re-worked when the overall footprint of the equipment was finalized.

TIME TO BUILD - AGAIN

When the decision was made that new space must be added to meet the projected space demands, the Bertner experience suggested that the traditional design-bid-build format needed to be abandoned for a more fast track method. The design build team of Hensel Phelps Construction Company was selected. Working with KMD and FKP Architects, the site master planning and design for the Ambulatory Clinical Building (ACB) were completed to facilitate a construction start of mid-July 2001.

The design/build team was selected to develop a generic building, while the strategic master planners were still considering what services would be provided in the space. The design phase would begin prior to the final site selection and programming. Additionally, master plans for Radiation Oncology and Imaging examining volumes and patient disease types and forecasting the number of modalities were being developed.

Moving to a disease focused/patient-centered approach

Concurrent to the realization that more space was needed, M. D. Anderson also decided to move to a disease-focused and patient-centered approach. By bringing all the specialties needed for diagnosis and treatment (medical and surgical) to the patient, the institution sought to improve the collaboration between caregivers as well as the patient experience. Previously, patients were required to visit Imaging, Surgery or Radiation Oncology departments separately. Reorganizing clinics by disease addressed part of the issue, but moving all the diagnostic x-ray, CT, MR, PET, radiation and chemotherapy into disease sites required study to ensure equipment was utilized properly and that the patient load could support the technology and technicians.

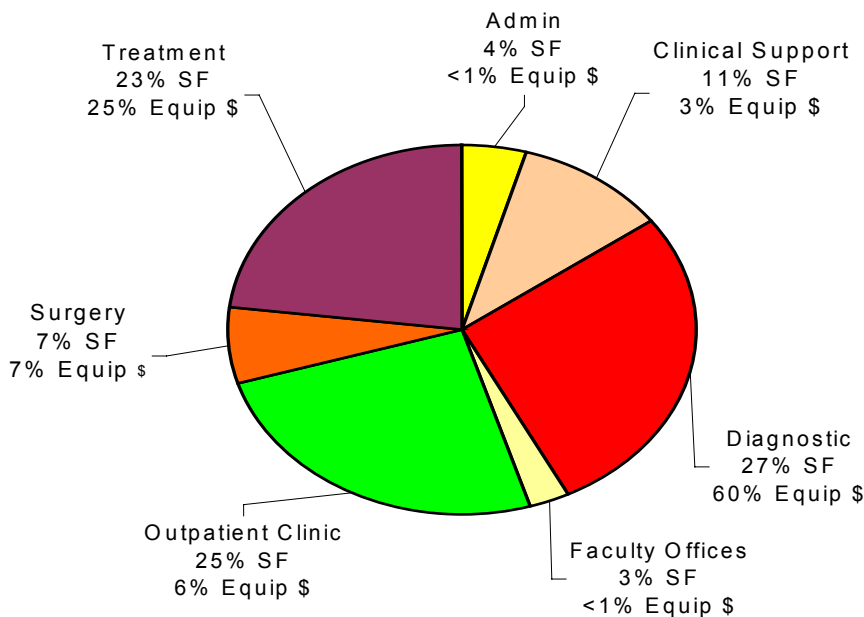
The disease-centered approach had already been put into action on the main campus redevelopment work and was successful. This confirmed the direction for the program components that would eventually need to be housed in the ACB.

After extensive study, clinics for three distinct disease types were identified to be placed in the new ACB – Breast Cancer, Gynecological Cancer and Genitourinary Cancer. To meet disease center goals not only clinics were placed in the new building, but all the services needed to support these patients including the diagnostic imaging, chemotherapy, radiation, pharmacy, lab, surgery and related specialties such as plastic surgery and internal medicine were positioned in the building as well.

Master Planning for ACB

The Phase I Ambulatory Clinical Building (781,400 gross square feet) is the first of several clinical buildings on the site currently occupied by the Houston Main Building, south of the main campus. The facility houses centers and clinics, Outpatient Diagnostic, Treatment/Surgery space, Imaging services, Radiation Oncology services staff offices, administrative space and support services. The master plan for the HMB site is based on a central courtyard with two - three levels of sub-surface parking and two levels of above grade parking. Above the four/five levels of parking, the Phase I Ambulatory Clinical Building includes five levels of clinic/office space, a public access floor and a mechanical mezzanine. The HMB site will connect to the main campus at the Lutheran Pavilion via an above grade pedestrian bridge.

The initial construction estimate was \$210,300,000* for the shell, core and buildout of ACB. Additionally the underground garage was estimated at \$20,900,000 and the bridge that connected the building back to \$19,500,000. Total construction cost was established at \$251,000,000, which included \$14,000,000 for contingencies. The project actually experienced an additional \$17,000,000 in changes which brought the final construction cost to \$268,000,000. Technology impacts accounted for \$6,000,000 or 20% of the total changes. While 25% of the total space is devoted to repetitive clinic modules, 57% of the space is comprised of technology complex areas including Imaging, Surgery and Radiation Oncology. 92% of the equipment budget was allocated to Imaging, Surgery and Radiation Oncology. Total equipment cost on the ACB was \$90 million - \$10 million under budget.



Applying Lessons learned on Alkek to ACB

Knowing that technology decisions were not made until the last minute on Alkek this design build team also had to find a way to plan and build a building prior to final technology decisions regarding what modalities would go into the building and which make and model would be selected.

As the world's leader in cancer treatment M. D. Anderson not only is expected to provide the latest and greatest technology, but also has a tradition of working side-by-side with manufacturers to identify new technologies to support patient care. Clinical research has proven the benefits of utilizing technology to improve the diagnosis and treatment of patients, translating to early diagnosis and accurate treatment that minimizes damage to healthy tissue surrounding tumors.

With the ACB strategies were revised to accommodate a fast tracked schedule. The institution could not afford the time to develop a generic plan, then build out custom rooms once technology was chosen. Lessons learned on Alkek revealed that even providing a slab depression proved useless, because the walls had to go up before technology decisions were made. On ACB the team was not dealing with one floor – with 12 rooms for Imaging. Imaging would now occupy more than a 1/3 of the building on various floors and in 84 rooms.

Key strategies for the building included zoning all Diagnostic Imaging spaces to the north end of the building, allowing for heavier footings and structural loads. The south end of the building (with the exception of Surgery) was then lighter and provided space for clinics and offices. Building construction proceeded with the north end first and an expansion joint was utilized to bring the buildings together into one finished envelope. Fast tracking the north end helped to keep the project on schedule and forced decisions on assumptions of weight criteria for the building.

By stacking identical floor plates and using clinic modules, the building allowed for flexibility of the floors to be re-stacked as program and adjacencies were finalized. Each floor plate is 95,000 BGSF.

The second major strategy was to establish a basis of design for each modality which meant that rooms were sized and planned to accommodate two or three manufacturers, allowing the institution time to select best products coming out of R&D at a later date. Each manufacturer submitted typical and room specific drawings to plan electrical, mechanical, and plumbing, and structure loads as well as size the room and shielding for the worst case. This enabled the infrastructure to go in, and be flexible to accept a range of manufacturers.

Addressing Technology Innovations

Clinicians and physicists at M. D. Anderson worked closely with manufacturers to bring them to the table to identify products coming out of research and development and negotiations were held to procure equipment not only for the ACB but for the campus and system as a whole.

Fusion Technology was being heavily introduced by the year 2000 with new innovations in Imaging and Radiation Oncology. Instead of clinicians having to marry a Computed Tomography (CT) image with a Positive Emission Tomography (PET) scan or a nuclear medicine scan to not only locate a tumor but to see the metabolic activity of the tumor, manufacturers were also producing equipment that fused these together in one imaging machine, such as PET/CT, Linear Accelerator/CT, Nuclear Medicine/PET/CT. Minimally invasive techniques for biopsies, radio frequency ablation and resection were requiring imaging modalities such as MRI's to be used in procedural/treatment environments and not merely used for diagnostics alone.

These trends in the market provided the backdrop for the design team to acknowledge that what is on the market during design would be vastly different than what would be available when the building opened and would continue to change in years to come. Also, it was anticipated that new modalities would require more cooling capability and power and would be larger in size and weigh more.

Globally, the strategies also included sizing main ductwork to accommodate almost twice the airflow in some areas. While smaller ducts were sized appropriately, the highway is in place if it's ever needed. Similarly,

electrical transformers were located to allow for future capacity and each floor was planned with stacking shaft spaces and equipment rooms for telecommunications, information systems and electrical. The building was also planned for wireless communications and an operational plan for an electronic medical record. The building will be filmless, with space devoted to scanning medical records or film to acquire the information digitally and incorporate referring information into the patient's record. Patients receive their original documents along with a CD with all the reports and images captured during their stay at the ACB.

Specific Strategies by Modality Type

New innovations in Radiation Oncology have introduced products, which bring Computed Tomography (CT) applications into the treatment vault and enable radiation to be targeted more exactly. All eight linear accelerator vaults were sized to accommodate a combination Linear Accelerator/CT. Two manufacturers provided room-specific drawings and the design team matched isocenters and designed the room size, infrastructure and shielding to accommodate either vendor.

As procurement decisions were finalized in early 2004, the institution determined that they did not have enough information to equip all eight rooms with a linac/CT combo. Clinical trials were still underway to prove effectiveness of a linac/CT combo that was already operational at main campus. Since a CT component adds \$1 Million to the room and is utilized less than 20% of the day, in lieu of providing a full-blown CT in the room, manufacturers produced another alternative to achieve similar results. The six linacs had been purchased for the ACB before the newest innovation called on-board imaging (OBI) was available for shipment. The OBI essentially provides the CT image through additional plates that are mounted like wings on the side of the linear accelerator. The extra conduit and power roughed in for the CT was used for the OBI's. Four other rooms received a linear accelerator and two rooms are shell space for future growth. An exterior penetration panel was provided to bring the vaults to a location above grade. With one occupied area below and two levels of parking it was structurally challenging to elevate the weight of five-foot thick concrete walls with 3" of lead shielding in all directions. There was a total of 4 million pounds of lead shielding in the building with the majority of the amount used in Radiation Oncology and PET.

At the same time, mammography was one of the last imaging modalities to go digital. As a primary tool in diagnosing breast cancer, the mammography film quality wasn't matched with digital quality during early market tests. M. D. Anderson closely watched major manufacturers success with achieving as good or better image quality with digital systems. Two manufacturers provided drawings and as the building neared completion a third vendor entered as a contender. The rooms were sized and roughed in based on two vendors but were able to accommodate any of the three. M. D. Anderson selected a mix of digital and analog systems from different manufacturers to allow comparison of quality and to allow applications for clinical prevention and diagnostics with different systems.

Magnetic Resonance Imaging (MRI) was more stable than other modalities. Rooms were sized based on a 3 Tesla magnet with a long bore – assuming worst case for size, weight, and mechanical requirements. The floor slab was depressed and access flooring was utilized. Ceiling penetration for quench duct was located for either a 1.5 Tesla, a 3 Tesla short bore or a 3 Tesla long bore. Room size worked around the various footprints and an exterior penetration panel was used. The MRI's were on the fifth floor above grade – again due primarily to the space the 83 imaging rooms required and stacking and adjacency requirements. While the structure was costly, having MRI's appropriately located was the priority.

Adjacent to the MRI suite is Interventional Radiology which houses one CT Procedure room, two ultrasound procedure rooms, two angiography suites and an interventional MRI. All these rooms were evaluated for different manufacturers and planned to accommodate ceiling mounted gas booms for anesthesia support.

Interventional MRI was the one modality with a delayed schedule due to evolving technology. Early planning drawings were provided but the room is essentially shelled with a depressed slab and will have a separate design and construction schedule still completing in 2005.

Unlike some of the other modalities Nuclear Medicine provided its own set of challenges. Programmatically it was the one service that was in the program originally, then out of the building when surgery was added to the scope, and finally nuclear medicine and PET were put back in the building after design development was underway. The reshuffle of several floors worked well given all floors had a module and the loading was designed for every floor to have imaging.

However, nuclear medicine also had another set of challenges just to design the rooms once it was determined where in the building they would be located. At project onset M. D. Anderson was fairly well settled on the manufacturer and model of choice and did not want to entertain options. The design build team was to design all rooms for a particular manufacturer and model that they were already using at main campus. No other manufacturer would be considered except for relocation of existing equipment that fit well within the specifications for the basis of design. Some expectations were made for a next generation from that manufacturer but a change in manufacturer was never considered as it was in other room types. Room specific drawings were obtained and the design and construction proceeded.

During construction, innovations in the marketplace drove a decision to shift to another manufacturer with a product in R&D. A next generation model was also being developed by that manufacturer but drawings for it did not exist. The design build team had only the current model information to go by. With 11 nuclear medicine rooms designed around two cores, there was not a lot leeway to modify room size. Studs were already in place when the manufacturer provided the minimum room sizing. Space had to be taken from within the core to lengthen the room. Additionally, HVAC and electrical changes were substantial and the design and construction changes delayed occupancy of the Nuclear Medicine space back several months.

Resources

M. D. Anderson's in house staff from Capital Planning and Management provided the day to day contact between departments and the design build team. CPM coordinators participated in design meetings, construction walkthroughs, furniture and equipment meetings, signage and key discussions, telecommunications, information systems, training, activation and move-in. The design build team led by Hensel Phelps Construction Co., KMD, and FKP Architects assembled a team of 32 consultants listed in the appendix. Equipment Collaborative was contracted through the design team for planning, procurement and installation of equipment and coordinated the procurement of \$90 million in new equipment comprised of major imaging equipment and included everything down to the trash cans and clocks. Over 800 orders were placed to account for over 20,000 assets. A 50,000 SF warehouse was rented to stage, assembly and deploy by phase to the new building over a period of several months.

Bringing 84 imaging rooms on line required an enormous resource demand for M. D. Anderson physicists who were not only supporting day-to-day operations at the main campus but who also had to be present and perform weeks of testing of each room. Resources by name were scheduled throughout the course of the project to align with construction and occupancy targets. Vendors were on site and participated in weekly construction walkthroughs. Having full time manufacturers representatives assigned to the project accounted for savings in construction. By partnering with the design and construction team to offer recommendations and consultation, the approach ensured that the installation of owner- furnished imaging equipment proceeded in an integrated fashion. Providing timely receipt of electrical back boxes, base plates and rails and other owner- furnished contractor installed items required open communication between the vendor and the contractor.

In addition to the ACB, M. D. Anderson, Hensel Phelps and FKP Architects, EC and many of the same consultants were part of the design build team for the adjacent Cancer Prevention Building (CPB). As the ACB became oversubscribed in planning with diagnostics and treatment space, all the faculty and prevention functions were located in the CPB. These two buildings were constructed simultaneously and activated as one major project starting in late 2004 and commencing in the spring of 2005. Freeman Enterprises was added as the move consultant to coordinate the activation and relocation for these two buildings. In addition to these two buildings

M. D. Anderson also had two research buildings nearing completion that placed additional demand on CPM staff and other resources such as IT and Telecommunications, Health and Safety, etc.

CONCLUSION

Given the pace and complexity of the ACB project, the strategies used for design and construction adapted well to the final equipment selections in most of the rooms. Having the room sized well, with power and HVAC in place, allowed decisions to be based on market conditions and not on design and construction schedules.

A design build strategy worked well for M. D. Anderson to allow a central point of responsibility, a faster delivery speed and a means to control costs. In any hi-tech project constructed under fast track or design bid build conditions, there is a need to strategize about imaging technology decisions early in the project and validate those decisions during design and construction. Given the expense of the investment and the impact the modality has on patient care it is a decision that must be made when market conditions are right. Engaging end users into scenario planning and encouraging vendors to share information assists the design team with information about potential options. Utilizing one or more manufacturers as a basis of design has proven to be more flexible than designing the room around one manufacturer or shelling the room until a decision is made.

APPENDIX – PROJECT TEAM

Hensel Phelps Construction Co.	Design Builder
FKP Architects, Inc.	Architect of Record, Interior Design and Furnishing Consultant
Kaplan MacLaughlin Diaz	Design Architect
Walter P. Moore and Associates, Inc.	Civil, Structural, Parking and Traffic Engineers
Affiliated Engineers, Inc. & Shah Smith and Associates	Mechanical, Electrical, Plumbing & Fire Protection Engineers
Clark Condon Associates	Landscape Architect
BD Healthcare Consulting and Services	Materials Management Consultant
Candela Architectural Lighting	Exterior Lighting Consultant
Cermak Peterka Petersen, Inc.	Wind Engineering Consultant
Colin Gordon Associates	Vibration and Acoustical Consultant
Eckroth Planning Group	Imaging Program Consultant
Equipment Collaborative, Inc.	Equipment Planning, Procurement & Installation Consultant
Fd2s	Graphics/Wayfinding Consultant
Frank Clements Associates, Inc.	Food Service Consultant
Freeman Enterprises	Move Consultant
Hermes Systems Management	Imaging Shielding Consultant
Hoover + Keith, Inc.	Acoustical and Audio Visual Consultant
McCrary Engineering, Inc.	Window Washing Consultant
MCM Security Design Consultant	Security Consultant
Michael John Smith Lighting	Interior Lighting Consultant
O'Neill Hill & Associates, LLC	Interior Design / Furniture Consultant
Pershon/Hahn Associates, Inc.	Vertical Transportation Consultant

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Rolf Jensen & Associates, Inc.

Life Safety Consultant

Show Fountains

Fountain Consultant

Southwest Research Institute

Radiation Oncology Shielding Consultant

Sparling Technology Consulting

Information Technology Consultant

Swisslog North America

ETV Consultant

Wilford Baker Engineering

Risk Consultant

Wiss, Janney, Elstner Associates, Inc.

Waterproofing, Curtainwall Roofing Consultant